**Title: Explainable AI-driven hybrid deep learning framework for accurate skin cancer diagnosis**

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**Abstract:** Objectives: To develop and evaluate a hybrid, partially interpretable deep learning (DL) approach for multi-class skin cancer classification that improves robustness under varying acquisition conditions and delivers clinically meaningful explanations. Methods: The proposed pipeline starts with preprocessing, including hair artefact removal using the Dull Razor method and anisotropic diffusion filtering for noise reduction while preserving lesion boundaries. Data augmentation is limited to the training set to prevent leakage. Class imbalance is addressed using class-weighted cross-entropy loss. EfficientNetB0 serves as the backbone CNN, and global feature embeddings are used to train a Random Forest (RF) classifier. Predictions are made by combining outputs from the deep model and the RF through probability-level fusion. The framework is evaluated on the HAM10000 dataset (7 classes) and a combined ISIC2019+DermNet dataset (8 classes). Performance metrics are compared against strong Vision Transformer (ViT) and transfer learning baselines. A proof-of-concept web application is developed for explainable decision making. Results: The proposed model achieves 98.61% accuracy and 98.60% F1-score on the combined dataset. It reaches 95.02% accuracy and 95.06% F1-score on HAM10000 using lesion-wise 5-fold cross-validation. For melanoma-specific evaluations, it demonstrates high sensitivity and AUC, indicating strong performance on critical cases. Grad-CAM maps suggest that the network highlights potentially important diagnostic lesion areas. Conclusion: The results indicate that partially interpretable architectures are a promising direction for robust skin cancer classification. The integration of Grad-CAM explanations and a web-based interface indicates that our framework may serve as a useful exploratory clinical decision-support tool.

**Keywords:** deep learning; explainable AI; healthcare workflow; hybrid modeling; medical imaging; skin cancer.

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